

PROJECT PLANNING AND MANAGEMENT

PROJECT RISK ANALYSIS AND MANAGEMENT

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CHAPTER

11

Chapter Introduction

Every project is exposed to uncertainty.

Uncertain events may affect:

- Project objectives
- Scope
- Schedule
- Cost
- Quality
- Benefits
- Safety
- Reputation
- Sustainability

Project risk management provides a systematic process for identifying, analyzing, responding to and monitoring these uncertainties.



CENTRAL MANAGEMENT QUESTION

What uncertain events could affect the project, how serious are they, and what should management do before they threaten project success?



Learning Objectives

By the end of this chapter, students will be able to:

- Define project risk and uncertainty
- Distinguish risks, issues, assumptions and constraints
- Explain the objectives of project risk management
- Identify project risks systematically
- Classify risks into meaningful categories
- Conduct qualitative risk assessment
- Apply probability–impact analysis
- Prioritize risks
- Conduct quantitative risk analysis
- Calculate Expected Monetary Value
- Apply decision-tree analysis
- Conduct sensitivity analysis
- Prepare optimistic, base and pessimistic scenarios
- Select risk-response strategies
- Prepare and maintain a risk register
- Establish risk-monitoring and escalation systems
- Evaluate residual and secondary risks
- Develop a project contingency framework



Chapter Roadmap

This chapter covers:

1. Meaning of project risk
2. Risk-management process
3. Risk identification
4. Risk categories
5. Qualitative risk assessment
6. Probability–impact analysis
7. Quantitative risk analysis
1. Expected Monetary Value
2. Sensitivity analysis
3. Scenario analysis
4. Risk-response planning
5. Risk registers
6. Monitoring and escalation
7. Integrated project-risk application

Opening Reflection

The Project Has

- Positive Net Present Value
- Strong market demand
- Appropriate technology
- Adequate financing

However

- Raw-material prices are volatile
- Equipment must be imported
- The project site is flood-prone
- Key staff are difficult to recruit
- Government regulations may change

Is the project still feasible?

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Section 1

Meaning of Project Risk

What Is Project Risk?

Project risk is an uncertain event or condition that, if it occurs, may affect one or more project objectives.

The effect may be:

- Negative
- Positive
- Direct
- Indirect
- Short term
- Long term



Risk as Uncertainty

Risk exists because future project conditions are not known with certainty.

Examples include uncertainty concerning:

- Demand
- Prices
- Costs
- Technology
- Weather
- Regulations
- Contractor performance
- Stakeholder behavior

Threats and Opportunities

Threat

An uncertain event that may negatively affect project objectives.

Opportunity

An uncertain event that may positively affect project objectives.

Risk management should address both.



Examples of Threats

- Construction delay
- Cost escalation
- Equipment breakdown
- Labour shortage
- Market decline
- Regulatory restriction
- Community opposition
- Financing delay



Examples of Opportunities

- Faster-than-expected market growth
- Lower equipment cost
- Tax incentive
- New technology
- Stronger supplier partnership
- Early project completion
- Increased export demand

Risk versus Issue

Risk

An uncertain future event that may or may not occur.

Issue

A current event or problem that has already occurred and requires action.

Risk and Issue Example

Risk

The imported machinery may arrive late.

Issue

The imported machinery has already missed the contractual delivery date.

Risk versus Assumption

Assumption

A condition accepted as true for planning purposes.

Risk

The uncertainty that the assumption may prove incorrect.

Assumption Example

Assumption

The project will receive uninterrupted electricity.

Associated Risk

Frequent power interruptions may reduce production and damage equipment.

Risk versus Constraint

Constraint — a known limitation within which the project must operate.

Examples:

- Fixed budget
- Legal deadline
- Limited land
- Required technology
- Maximum staffing level

Risk versus Uncertainty

Uncertainty

A broader lack of complete knowledge about future conditions.

Risk

An uncertainty that can be described in relation to project objectives and, in some cases, assigned probability and impact.

Risk Cause–Event–Effect Structure

A useful risk statement identifies three connected elements:

Cause

The existing condition or driver that gives rise to the risk.

Risk Event

The uncertain occurrence that may or may not happen.

Effect

The consequence on one or more project objectives.

Risk Statement Formula

A well-formed risk statement follows a consistent structure:

Because of [cause], there is a possibility that [event] may occur, resulting in [effect on objectives].

Risk Statement Example

Because customs clearance procedures are unpredictable, imported machinery may arrive later than planned, causing construction delay and additional financing cost.

Weak Risk Statement

“Equipment risk.”

This statement is too vague because it does not identify:

- Cause
- Event
- Consequence

Improved Risk Statement

Because the equipment supplier has limited local technical support, major equipment failures may remain unresolved for extended periods, reducing production capacity and revenue.

Risk Appetite

Risk appetite is the amount and type of risk an organization is willing to pursue or retain in order to achieve its objectives.



Risk Tolerance

Risk tolerance defines the acceptable variation around a specific objective.

Examples:

- Schedule delay not exceeding 30 days
- Cost variance not exceeding 10%
- Minimum DSCR of 1.20
- Maximum injury frequency rate

Risk Threshold

A risk threshold is the point at which exposure becomes unacceptable and requires escalation or additional action.

Risk Exposure

Risk exposure combines the likelihood of a risk with the magnitude of its possible effect.

A simplified measure is:

$$\text{Risk Exposure} = \text{Probability} \times \text{Impact}$$

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Section 2

Project Risk-Management Process



What Is Risk Management?

Project risk management is the systematic process of:

- Planning risk activities
- Identifying risks
- Analyzing risks
- Planning responses
- Implementing responses
- Monitoring risk exposure



Risk-Management Objectives

Risk management seeks to:

- Increase the probability of project success
- Reduce negative surprises
- Protect project value
- Improve decision-making
- Allocate contingency
- Clarify accountability
- Exploit opportunities



Risk-Management Process

1. Plan Risk Management
2. Identify Risks
3. Analyze Risks

1. Plan Responses
2. Implement Responses
3. Monitor and Escalate



Risk-Management Planning

Risk-management planning determines:

- Methodology
- Roles
- Responsibilities
- Risk categories
- Scoring scales
- Reporting formats
- Review frequency
- Escalation thresholds



Risk-Management Plan

A risk-management plan may include:

- Objectives
- Definitions
- Risk categories
- Probability and impact scales
- Risk matrix
- Risk ownership
- Reporting procedures
- Contingency rules
- Escalation process



Risk Governance

Risk governance may involve:

- Board
- Project sponsor
- Steering committee
- Project manager
- Risk owners
- Internal audit
- Specialized technical experts



Project Sponsor's Risk Role

The sponsor may:

- Approve risk appetite
- Accept major residual risks
- Authorize contingency
- Resolve escalated risks
- Support cross-organizational responses
- Report major exposure to senior management



Project Manager's Risk Role

The project manager should:

- Facilitate risk identification
- Maintain the risk register
- Coordinate analysis
- Assign risk owners
- Track response actions
- Escalate major risks
- Integrate risk into project decisions



Risk Owner

A risk owner is the individual accountable for:

- Monitoring a specific risk
- Developing the response
- Implementing agreed actions
- Reporting changes in exposure
- Escalating when thresholds are exceeded

Action Owner

An action owner is responsible for completing a specific risk-response activity.

The risk owner remains accountable for the overall risk.



Risk Management Is Continuous

Risk management is not a one-time exercise.

Risks change because of:

- Project progress
- New information
- Design changes
- External events
- Response effectiveness
- Emerging issues

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Section 3

Risk Identification

What Is Risk Identification?

Risk identification is the process of determining which uncertainties may affect project objectives and documenting their characteristics.



Objectives of Risk Identification

The process should:

- Identify threats and opportunities
- Identify causes
- Identify consequences
- Recognize interdependencies
- Support early response
- Build a shared understanding



When to Identify Risks

Risk identification should occur:

- During project conception
- During feasibility analysis
- Before approval
- During planning
- Before major procurement
- During implementation
- Before handover
- During operations

Sources of Risk Information

Information may come from:

- Feasibility studies
- Assumption logs
- Contracts
- Project schedules
- Cost estimates
- Stakeholder consultations
- Site visits
- Previous projects
- Audit reports



Risk-Identification Methods

Methods include:

- Brainstorming
- Interviews
- Workshops
- Checklists
- SWOT analysis
- Root-cause analysis
- Assumption analysis
- Document review
- Expert judgment



Brainstorming

Brainstorming brings project participants together to generate possible risks without immediate criticism.

It is useful for:

- Early-stage projects
- Cross-functional perspectives
- Rapid risk identification
- Building team ownership



Risk Workshop

A structured risk workshop may involve:

- Project sponsor
- Project manager
- Technical staff
- Finance staff
- Procurement staff
- Operations
- External experts
- Key stakeholders



Interviews

Individual interviews may uncover risks that participants are unwilling to raise in a group.

They are useful for:

- Sensitive risks
- Technical risks
- Political risks
- Governance concerns
- Contractor-performance concerns

Checklist Analysis

A checklist uses known risk categories or lessons from previous projects.

Advantages

- Efficient
- Standardized
- Easy to apply

Limitation

- May overlook new or unique risks



Lessons-Learned Review

Historical project records may reveal recurring risks such as:

- Cost overruns
- Procurement delays
- Contractor claims
- Weak stakeholder consultation
- Poor-quality data
- Implementation bottlenecks

SWOT-Based Risk Identification

Strengths

Internal factors that may create opportunities.

Weaknesses

Internal factors that may create threats.

Opportunities

External conditions that may improve results.

Threats

External conditions that may harm results.



Assumption Analysis

For each assumption, ask:

- Is it valid?
- What evidence supports it?
- How stable is it?
- What happens if it fails?
- Who should monitor it?



Root-Cause Analysis

Root-cause analysis seeks to identify underlying reasons a risk may occur.

Methods may include:

- Five Whys
- Fishbone diagram
- Process analysis
- Fault-tree analysis

Five Whys Example

Problem — Construction may be delayed.

1. Why? Materials may arrive late.
2. Why? Orders may be placed late.
3. Why? Technical specifications may be delayed.
4. Why? Design approval is slow.
5. Why? Decision authority is unclear.

Root cause: weak governance and approval arrangements.

Process-Flow Risk Analysis

Review each project process to identify where failure may occur.

**Specification → Tender → Evaluation →
Contract**
→ Delivery → Inspection → Payment

Each stage may create different risks.



Stakeholder Risk Identification

Stakeholder-related risks may arise from:

- Opposition
- Conflicting interests
- Poor communication
- Unrealistic expectations
- Weak participation
- Political influence
- Lack of ownership

Risk Breakdown Structure

A Risk Breakdown Structure organizes risks into hierarchical categories.

Sample Risk Breakdown Structure

External Risks

- Economic
- Political
- Regulatory
- Environmental

Internal Risks

- Technical
- Financial
- Management
- Operational

Project-Management Risks

- Scope
- Schedule
- Cost
- Procurement
- Communication



Risk Identification Output

The main output is an initial list of risks containing:

- Risk description
- Cause
- Potential effect
- Risk category
- Initial owner
- Existing controls

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Section 4

Risk Categories



Why Categorize Risks?

Risk categories help:

- Improve completeness
- Identify concentration
- Assign specialists
- Analyze common causes
- Organize reporting
- Support portfolio oversight



Strategic Risks

Strategic risks may arise from:

- Weak alignment
- Changing corporate priorities
- Incorrect business model
- Competitor response
- Loss of strategic relevance
- Poor portfolio selection



Market Risks

Market risks include:

- Lower demand
- Reduced selling price
- Customer concentration
- Changing preferences
- New substitutes
- Strong competitor response
- Market-entry delay



Technical Risks

Technical risks may include:

- Technology failure
- Design defects
- Capacity shortfall
- Quality failure
- Equipment incompatibility
- Rapid obsolescence
- Weak technical support



Construction Risks

Construction risks include:

- Site-condition problems
- Design changes
- Contractor failure
- Material shortage
- Weather delay
- Poor workmanship
- Safety incidents



Schedule Risks

Schedule risks may arise from:

- Unrealistic durations
- Delayed approvals
- Procurement lead times
- Resource shortage
- Rework
- Dependency failure
- Poor coordination



Cost Risks

Cost risks may include:

- Price escalation
- Quantity changes
- Design changes
- Exchange-rate movement
- Claims
- Rework
- Financing cost
- Tax changes



Financial Risks

Financial risks may include:

- Funding gap
- Loan-disbursement delay
- Interest-rate increase
- Foreign-exchange loss
- Liquidity shortage
- Debt-service failure
- Customer default



Procurement Risks

Procurement risks include:

- Weak specifications
- Limited competition
- Supplier failure
- Bid delay
- Contract disputes
- Delivery delay
- Poor-quality goods
- Fraud or conflict of interest



Operational Risks

Operational risks may include:

- Equipment breakdown
- Input shortage
- Staff turnover
- Weak maintenance
- Poor process control
- Utility interruption
- Quality variation



Organizational Risks

Organizational risks include:

- Unclear authority
- Weak governance
- Poor coordination
- Inadequate skills
- Leadership turnover
- Resistance to change
- Weak systems



Legal and Regulatory Risks

Examples include:

- Licence delay
- New regulation
- Tax change
- Contract unenforceability
- Land dispute
- Environmental noncompliance
- Labour-law violation



Environmental Risks

Environmental risks may include:

- Pollution
- Water scarcity
- Biodiversity loss
- Flooding
- Drought
- Soil contamination
- Climate-related disruption



Social Risks

Social risks may include:

- Community opposition
- Land acquisition
- Displacement
- Livelihood loss
- Labour conflict
- Inequality
- Gender-based violence
- Weak stakeholder acceptance



Health and Safety Risks

Examples include:

- Worker injury
- Fatality
- Fire
- Chemical exposure
- Traffic accident
- Community injury
- Disease outbreak
- Equipment failure



Political Risks

Political risks may include:

- Policy change
- Civil unrest
- Expropriation
- Government instability
- Political interference
- Trade restriction
- Regional conflict



Macroeconomic Risks

Macroeconomic risks include:

- Inflation
- Recession
- Exchange-rate volatility
- Interest-rate changes
- Foreign-exchange shortages
- Commodity-price movements



Force-Majeure Risks

Force-majeure events may include:

- Earthquake
- Flood
- War
- Epidemic
- Severe storm
- Government embargo
- Major civil disturbance



Reputational Risks

Reputational risks may arise from:

- Environmental damage
- Community complaints
- Corruption allegations
- Safety incidents
- Poor product quality
- Human-rights concerns
- Misleading communication



Opportunity Categories

Opportunities may arise from:

- Higher demand
- Faster implementation
- Lower input cost
- Better technology
- New partnership
- Government incentive
- Process efficiency
- Stronger market access

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Section 5

Qualitative Risk Assessment

What Is Qualitative Risk Assessment?

Qualitative risk assessment evaluates the relative priority of identified risks using descriptive or ordinal measures.



Purpose of Qualitative Assessment

It helps management:

- Prioritize risks
- Focus limited resources
- Assign owners
- Select risks for quantitative analysis
- Determine reporting level
- Identify urgent actions



Main Assessment Factors

Risks may be assessed using:

- Probability
- Impact
- Urgency
- Proximity
- Manageability
- Detectability
- Persistence
- Interdependency

Probability

Probability is the likelihood that a risk event will occur.

Probability Scale

Rating	Description	Indicative Probability
1	Rare	Below 10%
2	Unlikely	10–30%
3	Possible	31–50%
4	Likely	51–70%
5	Almost certain	Above 70%



Impact

Impact is the effect of a risk on project objectives if the event occurs.

Impacts may affect:

- Cost
- Schedule
- Scope
- Quality
- Safety
- Benefits
- Reputation

Impact Scale

Rating	Description	General Effect
1	Insignificant	Minimal effect
2	Minor	Limited corrective action
3	Moderate	Noticeable objective impact
4	Major	Serious objective impact
5	Severe	Project viability threatened

Cost-Impact Example

Rating	Cost Impact
1	Less than 2%
2	2–5%
3	6–10%
4	11–20%
5	Above 20%

Schedule-Impact Example

Rating	Schedule Delay
1	Less than one week
2	One to four weeks
3	One to three months
4	Three to six months
5	More than six months

Safety-Impact Example

Rating	Safety Effect
1	No injury
2	First-aid case
3	Lost-time injury
4	Permanent disability
5	Fatality or multiple severe injuries

Risk Urgency

Urgency considers how quickly action is required.

A high-impact risk may require less immediate attention if it cannot occur for several years.



Risk Proximity

Proximity refers to how soon the risk event may occur.

Examples:

- Immediate
- Within three months
- Within one year
- Later in the project

Risk Detectability

Detectability assesses how easily warning signs can be observed before the risk occurs.

Low detectability may increase management concern.



Risk Manageability

Manageability assesses whether the project team can influence:

- Probability
- Impact
- Timing
- Recovery

Qualitative Risk Score

A common scoring approach is:

$$\text{Risk Score} = \text{Probability Rating} \times \text{Impact Rating}$$

Risk-Score Example

- Probability rating: 4
- Impact rating: 5

$$\text{Risk Score} = 4 \times 5 = 20$$

This is normally treated as a high-priority risk.



Risk Priority Categories

Example:

- 1–4: Low
- 5–9: Moderate
- 10–16: High
- 17–25: Critical

Thresholds should reflect organizational risk tolerance.



Limitations of Qualitative Scores

Risk scores may be affected by:

- Subjective judgment
- Inconsistent interpretation
- False precision
- Different impact dimensions
- Failure to consider interdependencies
- Weak probability estimates



Improving Assessment Quality

Use:

- Clear definitions
- Calibrated scales
- Evidence
- Multiple experts
- Facilitated workshops
- Independent review
- Regular updates

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Section 6

Probability–Impact Analysis

Probability–Impact Matrix

A probability–impact matrix combines likelihood and consequence to classify risk priority.

Five-by-Five Matrix

P \ Impact	1	2	3	4	5
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

Matrix Interpretation

Critical

Immediate senior-management attention.

High

Specific response and frequent monitoring.

Moderate

Manage through planned controls.

Low

Monitor and accept where appropriate.

Probability–Impact Example

Risk: imported machinery may arrive late.

- Probability: 4
- Schedule impact: 4

$$\text{Score} = 4 \times 4 = 16$$

Risk category: High.



Multi-Dimensional Impact

A risk may affect several objectives. Example — machinery delay may affect:

- Schedule: 4
- Cost: 3
- Revenue: 4
- Reputation: 2

Highest-Impact Approach

One approach is to use the highest impact rating across objectives.

For the example:

Impact = 4

Weighted-Impact Approach

An organization may weight objectives differently.

Example:

- Cost: 30%
- Schedule: 30%
- Quality: 20%
- Safety: 20%

Weighted-Impact Formula

$$\text{Weighted Impact} = \sum (\text{Impact}_i \times \text{Weight}_i)$$

Risk Impact Scale

Score	Impact Level	Description
1	Negligible	No significant effect on objectives or operations.
2	Minor	Minor delays or localized impact.
3	Moderate	Noticeable disruption requiring management attention.
4	Severe	Significant impact on programme delivery and organizational objectives.
5	Critical	Major organizational failure or inability to achieve objectives.

Likelihood Scale

Score	Likelihood	Historical Occurrence	Forward-Looking
1	Very Unlikely	Never occurred	Very unlikely in foreseeable future
2	Unlikely	Once in 5–10 years	Unlikely in foreseeable future
3	Moderately Likely	Once in 2–4 years	Likely within 2–4 years
4	Likely	One or more times in last 12 months	Likely within 12–24 months
5	Very Likely	Occurs regularly	Expected within the next 6 months



Risk Heat Map

A risk heat map visually groups risks by:

- Probability
- Impact
- Priority level

It supports management communication and escalation.

Risk Assessment Matrix (Heat Map)

Likelihood ↓ / Impact →	1 Negligible	2 Minor	3 Moderate	4 Severe	5 Critical
5 Very Likely	5	10	15	20	25
4 Likely	4	8	12	16	20
3 Moderately Likely	3	6	9	12	15
2 Unlikely	2	4	6	8	10
1 Very Unlikely	1	2	3	4	5

 **Low** Score 1–6

 **Moderate** Score 7–12

 **High** Score 13–25

Risk Ranking

Risk Classification

Score	Rating
1–6	Low
7–12	Moderate
13–25	High

MANAGEMENT ATTENTION



Low

→ Monitor



Moderate

→ Mitigate



High

→ Immediate Action

Inherent Risk

Inherent risk is the level of risk before considering existing controls or planned responses.

Residual Risk

Residual risk is the risk remaining after controls and responses are implemented.



Control Effectiveness

Controls may be rated as:

- Effective
- Partially effective
- Weak
- Not established

Residual-Risk Example

Inherent score: 20. After supplier guarantees, early ordering and backup sourcing:

- Probability falls from 4 to 2
- Impact remains 5

$$\text{Residual score} = 2 \times 5 = 10$$

Secondary Risk

A secondary risk is a new risk created by implementing a risk response.

Example — using an alternative supplier reduces delivery risk but may increase product-quality risk.



Risk Interdependency

Risks may be connected. Example:

1. Currency depreciation increases equipment cost
2. Higher cost creates a financing gap
3. Financing delay affects schedule
4. Schedule delay reduces projected NPV

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Section 7

Quantitative Risk Analysis

What Is Quantitative Risk Analysis?

Quantitative risk analysis numerically estimates how uncertainty may affect project outcomes.



Purpose of Quantitative Analysis

It may estimate:

- Expected project cost
- Expected completion date
- Probability of meeting objectives
- Required contingency
- Expected NPV
- Downside exposure
- Range of possible outcomes



When Quantitative Analysis Is Useful

It is particularly useful for:

- Large projects
- Complex projects
- Capital-intensive projects
- Projects with high uncertainty
- Projects requiring external financing
- Projects with tight deadlines



Quantitative Methods

Methods may include:

- Expected Monetary Value
- Decision trees
- Sensitivity analysis
- Scenario analysis
- Simulation
- Probability distributions
- Schedule-risk analysis



Data Requirements

Quantitative analysis requires estimates of:

- Probability
- Financial effect
- Schedule effect
- Correlation
- Range
- Distribution
- Dependency



Probability Distribution

A probability distribution describes possible values of an uncertain variable and their likelihood.

Common distributions include:

- Triangular
- Normal
- Uniform
- Lognormal
- Beta



Three-Point Estimate

A three-point estimate uses:

- Optimistic value
- Most likely value
- Pessimistic value

Triangular Expected Value

A simple estimate is:

$$E(X) = (O + M + P) / 3$$

Where:

- O = optimistic
- M = most likely
- P = pessimistic

PERT Estimate

$$E(X) = (O + 4M + P) / 6$$

This gives greater weight to the most likely estimate.

PERT Example

- Optimistic: 8 months
- Most likely: 10 months
- Pessimistic: 16 months

$$E(X) = (8 + 4(10) + 16) / 6$$
$$= 10.67 \text{ months}$$



Simulation

Simulation repeatedly calculates project outcomes using random values from selected probability distributions.

It may estimate:

- Probability of negative NPV
- Probability of cost overrun
- Probability of schedule delay
- Percentile contingency



Simulation Output

Possible simulation outputs include:

- Mean outcome
- Median outcome
- Standard deviation
- Probability distribution
- Confidence interval
- P50 and P90 estimates

P50 Estimate

A P50 estimate is the value with approximately a 50% probability of not being exceeded.

P90 Estimate

A P90 estimate is the value with approximately a 90% probability of not being exceeded.

It is more conservative than P50.



Quantitative-Analysis Limitations

- Data may be weak
- Probability estimates may be subjective
- Correlations may be ignored
- Models may be misunderstood
- Results may create false confidence
- Extreme events may be underrepresented

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Section 8

Expected Monetary Value



What Is Expected Monetary Value?

Expected Monetary Value combines:

- Probability of occurrence
- Monetary consequence

to estimate the average expected financial effect of an uncertain event.

EMV Formula

$$\text{EMV} = \text{Probability} \times \text{Monetary Impact}$$

Threat EMV

A threat normally has a negative monetary impact.

Example:

- Probability: 30%
- Cost impact: \$100,000

$$EMV = 0.30 \times (-100,000) = -\$30,000$$

Opportunity EMV

An opportunity normally has a positive monetary impact.

Example:

- Probability: 40%
- Benefit: \$80,000

$$EMV = 0.40 \times 80,000 = \$32,000$$

Combined EMV

Threat EMV = -\$30,000

Opportunity EMV = +\$32,000

Net EMV = +\$2,000



EMV and Contingency

The sum of expected monetary values of identified risks may inform contingency planning.

However, management should also consider:

- Correlation
- Extreme events
- Risk tolerance
- Unknown risks
- Timing

EMV Table

Risk	Probability	Impact	EMV
Material-price increase	40%	-\$200,000	-\$80,000
Early completion incentive	20%	+\$100,000	+\$20,000
Equipment failure	15%	-\$300,000	-\$45,000

Net EMV = -\$105,000



Decision-Tree Analysis

A decision tree evaluates decisions under uncertainty by showing:

- Decision alternatives
- Possible events
- Probabilities
- Payoffs
- Expected values

Decision Node

A decision node represents a choice controlled by management.

It is often shown as a square.

Chance Node

A chance node represents an uncertain event outside management's direct control.

It is often shown as a circle.

Decision-Tree Example

A company may choose between:

Option A

Purchase standard equipment.

Option B

Purchase advanced equipment.

Each option has different probabilities of success and failure.



Option A Data

- Success probability: 80%
- Success payoff: \$500,000
- Failure probability: 20%
- Failure payoff: −\$100,000

Option A EMV

$$EMV(A) = 0.80(500,000) + 0.20(-100,000)$$

$$EMV(A) = \$380,000$$



Option B Data

- Success probability: 60%
- Success payoff: \$800,000
- Failure probability: 40%
- Failure payoff: −\$200,000

Option B EMV

$$EMV(B) = 0.60(800,000) + 0.40(-200,000)$$

$$EMV(B) = \$400,000$$

Decision-Tree Result

$EMV(B) > EMV(A) \rightarrow \text{Option B preferred}$

Management should still assess:

- Downside risk
- Financing capacity
- Risk appetite
- Strategic fit



Limitations of EMV

- Represents a long-run average
- May not reflect one-time project consequences
- Depends on probability quality
- May hide severe downside risk
- Does not fully capture nonfinancial effects

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Section 9

Sensitivity Analysis

What Is Sensitivity Analysis?

Sensitivity analysis measures how project results change when one input variable changes while other variables remain constant.



Purpose of Sensitivity Analysis

It helps identify:

- Critical variables
- Fragile assumptions
- Major value drivers
- Variables requiring monitoring
- Areas requiring stronger controls



Common Sensitivity Variables

- Sales volume
- Selling price
- Raw-material cost
- Investment cost
- Capacity utilization
- Implementation delay
- Interest rate
- Exchange rate
- Project life



Sensitivity Procedure

- | | |
|-------------------------------|---------------------------|
| 1. Establish base-case result | 1. Recalculate the result |
| 2. Select a variable | 2. Measure the effect |
| 3. Change the variable | 3. Compare variables |



Sensitivity Example

Base NPV: \$500,000.

Test changes:

- Sales volume decreases by 10%
- Selling price decreases by 10%
- Operating cost increases by 10%
- Project cost increases by 10%

Sensitivity Table

Variable Change	Revised NPV
Base case	\$500,000
Sales volume –10%	\$250,000
Selling price –10%	\$100,000
Operating cost +10%	\$300,000
Project cost +10%	\$400,000

Sensitivity Interpretation

The project is most sensitive to selling price because a 10% change produces the largest reduction in NPV.

Sensitivity Coefficient

A simplified sensitivity coefficient is:

$$\text{Sensitivity Coefficient} = \frac{\% \text{ Change in Outcome}}{\% \text{ Change in Variable}}$$

Tornado Diagram

A tornado diagram ranks variables according to their effect on a selected outcome.

The most influential variables appear at the top.

Switching Value

A switching value identifies the change in a variable required to make the project unacceptable.

For financial appraisal: $NPV = 0$

Selling-Price Switching Value

The switching value may answer:

By what percentage can selling price fall before NPV becomes zero?

Cost Switching Value

It may also answer:

By what percentage can project cost rise before the investment becomes unacceptable?



Sensitivity Limitations

- Changes one variable at a time
- May ignore relationships among variables
- Does not assign probabilities
- May use unrealistic changes
- Does not show complete outcome distributions

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Section 10

Scenario Analysis

What Is Scenario Analysis?

Scenario analysis evaluates project outcomes under internally consistent combinations of assumptions.

Sensitivity versus Scenario Analysis

Sensitivity Analysis

Changes one variable at a time.

Scenario Analysis

Changes several related variables together.



Common Scenarios

- Optimistic
- Base case
- Pessimistic
- Stress case
- Regulatory-change case
- Delayed-implementation case

Base Scenario

The base scenario uses the most realistic expected assumptions.



Optimistic Scenario

Possible assumptions:

- Higher demand
- Higher selling price
- Lower input cost
- Faster implementation
- Higher capacity utilization



Pessimistic Scenario

Possible assumptions:

- Lower demand
- Lower selling price
- Higher input cost
- Implementation delay
- Lower capacity utilization

Scenario Table

Variable	Optimistic	Base	Pessimistic
Sales growth	12%	8%	2%
Project cost	-5%	Planned	+20%
Start-up delay	None	3 months	12 months
Capacity Year 1	75%	60%	40%

Scenario Results

Scenario	NPV	IRR	Payback
Optimistic	\$2.0m	28%	3 years
Base	\$800,000	19%	4 years
Pessimistic	-\$500,000	9%	7 years



Scenario Interpretation

The project is financially attractive under the base and optimistic cases but fails under the pessimistic case.

Management should assess:

- Probability of the pessimistic case
- Ability to withstand losses
- Possible response measures
- Financing resilience



Stress Testing

Stress testing examines extreme but plausible conditions.

Examples:

- Sales fall by 30%
- Currency depreciates by 40%
- Project completion is delayed two years
- Main supplier fails
- Interest rate rises sharply

Reverse Stress Testing

Reverse stress testing asks:

What combination of events would cause the project to fail?

It helps identify critical failure conditions.



Scenario Limitations

- Scenarios may be subjective
- Important combinations may be omitted
- Probabilities may be unclear
- Extreme events may be underestimated
- Results depend on assumption consistency

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Section 11

Risk-Response Planning

What Is Risk-Response Planning?

Risk-response planning develops actions to address prioritized threats and opportunities.



Response Objectives

Responses should:

- Reduce probability
- Reduce impact
- Increase opportunity likelihood
- Improve recovery
- Clarify responsibility
- Remain cost-effective

Risk Response Options



Avoid

Stop the activity that creates the risk.



Reduce

Implement controls to reduce likelihood or impact.



Share

Transfer part of the risk through insurance, contracts, or partnerships.



Accept

Accept the risk because it is within the organization's risk appetite.



Pursue

Accept higher risk to achieve strategic opportunities.



Escalate

Refer the risk to a higher management level when it exceeds authority or appetite.



Avoidance

Avoidance eliminates the threat or protects the project from its effect.

Examples:

- Change location
- Remove risky scope
- Use proven technology
- Select another supplier
- Change project design



Mitigation

Mitigation reduces the probability or impact of the threat.

Examples:

- Additional testing
- Preventive maintenance
- Training
- Backup systems
- Early procurement
- Improved quality control



Transfer

Transfer shifts some financial or performance consequences to another party.

Examples:

- Insurance
- Fixed-price contract
- Warranty
- Performance guarantee
- Outsourcing
- Hedging



Transfer Does Not Eliminate Risk

Risk transfer may create:

- Contract risk
- Counterparty risk
- Premium cost
- Coverage exclusions
- Dispute risk

Ultimate accountability may remain with the project owner.

Acceptance

Acceptance means acknowledging the risk without taking immediate preventive action.

Passive

Take no action unless the risk occurs.

Active

Establish contingency plans or reserves.



When Acceptance Is Appropriate

Acceptance may be reasonable when:

- Risk is low
- Response cost exceeds expected loss
- No practical response exists
- The project can absorb the impact
- The risk is outside reasonable control



Escalation

Escalation transfers responsibility to a higher organizational level when the risk:

- Exceeds project authority
- Affects strategy
- Requires major funding
- Affects several projects
- Exceeds risk tolerance

Opportunity-Response Strategies

Opportunity responses include:

Exploit

Ensure it occurs.

Enhance

Increase likelihood.

Share

Partner to realize.

Accept

Benefit if it occurs.

Escalate

Raise to authority .

Exploit

Exploit seeks to ensure the opportunity occurs.

Examples:

- Assign best resources
- Accelerate implementation
- Secure exclusive agreement
- Invest in additional capacity



Enhance

Enhance increases the probability or positive impact of an opportunity.

Examples:

- Strengthen marketing
- Improve supplier relationships
- Increase training
- Adjust product design



Share

Sharing allocates opportunity ownership to a party better able to realize it.

Examples:

- Joint venture
- Strategic partnership
- Profit-sharing arrangement
- Technology partnership

Opportunity Acceptance

Management may accept an opportunity without proactive action but benefit if it occurs.



Response Selection Criteria

Select responses based on:

- Effectiveness
- Cost
- Feasibility
- Timing
- Risk appetite
- Stakeholder acceptance
- Secondary risks

Cost-Effective Response

A response is economically justified when the expected reduction in risk exposure exceeds the response cost.

Response-Cost Example

Expected loss before response = \$200,000

Expected loss after response = \$60,000

Risk reduction = \$140,000

Response cost = \$50,000

Net benefit = \$90,000

Contingency Plan

A contingency plan specifies what will be done if a risk event occurs.

Fallback Plan

A fallback plan is used when the primary response or contingency plan is ineffective.



Trigger Condition

A trigger is an observable sign indicating that a risk is about to occur or has occurred.

Examples:

- Supplier misses design milestone
- Exchange rate exceeds threshold
- Rainfall reaches critical level
- Cost variance exceeds 10%

Contingency Reserve

Contingency reserve is funding or time allocated for identified risks.

It is generally included in the project baseline.

Management Reserve

Management reserve covers unforeseen work or unknown risks.

It is normally controlled by senior management and may sit outside the cost baseline.

Risk-Adjusted Budget

$$\text{Risk-Adjusted Budget} = \text{Base Estimate} + \text{Contingency Reserve} + \text{Management Reserve}$$



Schedule Contingency

Schedule contingency may include:

- Buffers
- Float
- Additional lead time
- Alternative sequencing
- Early procurement
- Accelerated recovery plans

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Section 12

Risk Registers

What Is a Risk Register?

A risk register is a living document used to record and manage identified project risks.



Purpose of the Risk Register

It supports:

- Documentation
- Prioritization
- Accountability
- Response planning
- Monitoring
- Reporting
- Lessons learned

Core Risk-Register Fields

A risk register may contain:

- Risk ID
- Date identified
- Category
- Cause
- Event
- Effect
- Probability
- Impact
- Score
- Owner
- Response
- Status

Expanded Risk-Register Fields

Additional fields may include:

- Existing controls
- Inherent risk
- Response actions
- Action owner
- Due date
- Residual risk
- Trigger
- Escalation level
- Last review date

Sample Risk Register

ID	Risk	P	I	Score	Response	Owner
R01	Machinery delay	4	4	16	Order early	Procurement Head
R02	Cost escalation	3	5	15	Fixed-price contract	Project Manager
R03	Staff shortage	3	3	9	Early recruitment	HR Manager



Risk Status

Risk status may be:

- Open
- Under treatment
- Monitoring
- Escalated
- Occurred
- Closed
- Transferred

Risk Register versus Issue Log

Risk Register

Records uncertain future events.

Issue Log

Records current problems requiring resolution.

When a risk occurs, it may move to the issue log.

Risk Register versus Assumption Log

Risk Register

Tracks uncertain events.

Assumption Log

Tracks planning assumptions and their validity.

Assumption failure may generate a risk or issue.

Risk Register Ownership

The project manager may maintain the register, but risk owners are accountable for individual entries.



Risk-Register Review

Each review should confirm:

- Probability
- Impact
- Response progress
- Trigger status
- Residual risk
- New risks
- Closed risks
- Escalation needs



Closing a Risk

A risk may be closed when:

- The risk period has passed
- The event can no longer occur
- The risk has occurred and become an issue
- The risk is no longer relevant
- Exposure is formally accepted and monitored elsewhere

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Section 13

Risk Monitoring



What Is Risk Monitoring?

Risk monitoring tracks:

- Existing risks
- Response implementation
- Residual risks
- Secondary risks
- New risks
- Changes in project exposure



Monitoring Objectives

Risk monitoring should determine:

- Are assumptions still valid?
- Has probability changed?
- Has impact changed?
- Are responses working?
- Have triggers occurred?
- Are new risks emerging?



Risk Review Frequency

Risk reviews may be:

- Weekly for high-risk projects
- Monthly for normal project reporting
- Quarterly for governance oversight
- Event-driven after major changes
- Conducted before phase gates



Risk Indicators

A Key Risk Indicator provides early warning of increasing exposure.

Examples:

- Exchange-rate movement
- Supplier-performance decline
- Staff turnover
- Permit-processing delay
- Cost variance
- Safety near misses



Leading Risk Indicators

Leading indicators signal possible future problems.

Examples:

- Late design submission
- Declining equipment availability
- Unresolved complaints
- Increasing staff absenteeism
- Delayed procurement milestones



Lagging Risk Indicators

Lagging indicators show that a risk event has already occurred.

Examples:

- Cost overrun
- Missed milestone
- Injury
- Contract claim
- Regulatory penalty
- Production loss



Risk Trend

Risk trend may be classified as:

- Increasing
- Stable
- Decreasing
- Uncertain

Risk Burn-Down Chart

A risk burn-down chart tracks total risk exposure over time.

Expected pattern:

- High during early uncertainty
- Reduced through decisions and responses
- Lower near project closure



Risk Audit

A risk audit examines whether:

- Risk procedures are followed
- Responses are effective
- Owners are accountable
- Registers are current
- Escalation works
- Lessons are captured



Reserve Analysis

Reserve analysis compares:

- Remaining contingency
- Remaining risk exposure
- Expected future needs



Emerging Risks

Emerging risks are new or rapidly changing risks that may not be fully understood.

Examples:

- New regulation
- Cyber threat
- Political instability
- New technology
- Climate extremes
- Supply-chain disruption

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Section 14

Risk Escalation

What Is Risk Escalation?

Risk escalation transfers a risk to a higher level of authority when the project team cannot manage it within approved limits.



Escalation Criteria

Escalate when a risk:

- Exceeds financial authority
- Exceeds schedule tolerance
- Threatens strategic benefits
- Affects legal compliance
- Creates major safety exposure
- Affects several projects
- Requires policy change



Escalation Threshold Example

Escalate to the steering committee when:

- Cost exposure exceeds \$250,000
- Schedule delay exceeds 60 days
- Risk score exceeds 16
- Safety impact may be fatal
- Regulatory licence is threatened

Escalation Levels

Level 1

Project team

Level 2

Project
manager

Level 3

Sponsor or
steering
committee

Level 4

Board or
executive
management



Escalation Report

An escalation report should include:

- Risk description
- Current exposure
- Potential effect
- Actions taken
- Decision required
- Recommended response
- Time limit



De-Escalation

A risk may be returned to the project level when:

- Exposure decreases
- Authority becomes sufficient
- Required resources are provided
- Strategic concern is resolved



Risk Communication

Risk communication should be:

- Timely
- Accurate
- Transparent
- Decision-oriented
- Appropriate to the audience
- Free from unnecessary technical detail



Risk Dashboard

A management dashboard may show:

- Top ten risks
- Risk heat map
- Risk trend
- Overdue actions
- Contingency balance
- Escalated risks
- Emerging risks
- Opportunity status

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Section 15

Integrating Risk with Project Decisions



Risk and Project Selection

Risk analysis should influence:

- Project acceptance
- Project ranking
- Financing structure
- Required return
- Contingency
- Contract strategy
- Approval conditions



Risk-Adjusted NPV

Risk may be incorporated by:

- Adjusting cash flows
- Using scenario probabilities
- Using a risk-adjusted discount rate
- Calculating certainty equivalents
- Applying simulation

Expected NPV

$$E(NPV) = \sum P_i (NPV_i)$$

Where:

- P_i = probability of scenario i
- NPV_i = NPV under scenario i

Expected-NPV Example

Scenario	Probability	NPV
Optimistic	20%	\$2.0m
Base	50%	\$800,000
Pessimistic	30%	-\$500,000

$$\begin{aligned} E(\text{NPV}) &= 0.20(2.0\text{m}) + 0.50(800\text{k}) + \\ &\quad 0.30(-500\text{k}) \\ E(\text{NPV}) &= \$650,000 \end{aligned}$$

Expected Value Is Not Enough

The project may have a positive expected NPV but still carry severe downside risk.

Management should also examine:

- Probability of negative NPV
- Maximum loss
- Liquidity
- Debt-service capacity
- Reversibility
- Risk tolerance

Risk-Adjusted Discount Rate

Riskier projects may require a higher discount rate.

Apply carefully, because:

- Different risks affect different cash flows
- It may hide risk sources
- It may excessively penalize long-term benefits

Certainty Equivalent

A certainty equivalent adjusts an uncertain cash flow into a risk-adjusted amount considered equivalent to a certain cash flow.



Risk and Financing

Higher risk may affect:

- Interest rate
- Required equity
- Loan maturity
- Security
- Covenants
- Insurance
- Lender approval



Risk and Contract Strategy

Contract choices may allocate risks differently.

Examples:

- Fixed-price contract
- Cost-reimbursable contract
- Design–build
- Turnkey
- Public–private partnership
- Performance-based contract



Risk Allocation Principle

Risk should generally be allocated to the party best able to:

- Control it
- Reduce it
- Absorb it
- Monitor it
- Finance it



Poor Risk Allocation

Assigning risk to a party that cannot manage it may cause:

- Higher contract price
- Disputes
- Supplier failure
- Delays
- Claims
- Poor performance



Risk and Phase-Gate Decisions

At each phase gate, management should review:

- Major risks
- Residual exposure
- Response readiness
- Contingency adequacy
- New information
- Go, revise, hold or stop decision

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Section 16

Integrated Case Application

MBA Case Exercise

The project involves:

- Imported machinery
- Regional raw-material sourcing
- Bank financing
- 300 employees
- Export sales
- Significant water and energy use



Initial Risk Identification

Possible risks include:

- Exchange-rate depreciation
- Equipment-delivery delay
- Raw-material shortage
- Drought
- Low market acceptance
- Cost escalation
- Skilled-labour shortage
- Power interruption

Market Risk Example

Because customer acceptance of the new processed product is uncertain, sales volume may remain below forecast, reducing revenue and NPV.

Technical Risk Example

Because the selected technology has limited operating experience in the region, actual production efficiency may be below design capacity, increasing unit cost.

Financial Risk Example

Because the project loan has a variable interest rate, debt-service payments may increase, reducing DSCR and liquidity.

Environmental Risk Example

Because the project depends on groundwater, prolonged drought may reduce water availability and interrupt production.



Qualitative-Assessment Exercise

Rate each risk using:

- Probability: 1–5
- Impact: 1–5
- Risk score
- Priority category

Sample Risk Assessment

Risk	Probability	Impact	Score	Priority
Currency depreciation	4	5	20	Critical
Machinery delay	4	4	16	High
Labour shortage	3	3	9	Moderate
Minor office delay	2	1	2	Low

EMV Exercise

Risk: imported machinery price may increase by \$500,000. Probability: 30%.

$$EMV = 0.30 \times (-500,000) = -\$150,000$$

Opportunity EMV Exercise

Opportunity: government may grant a tax incentive worth \$300,000. Probability: 40%.

$$EMV = 0.40 \times 300,000 = \$120,000$$

Net EMV

Threat EMV = -\$150,000

Opportunity EMV = +\$120,000

Net EMV = -\$30,000



Sensitivity Exercise

Test NPV under:

- Sales volume –15%
- Selling price –10%
- Raw-material cost +20%
- Project cost +15%
- Start-up delay of one year

Scenario Exercise

Prepare three internally consistent scenarios:

Optimistic

- Strong demand
- Stable currency
- Early completion

Base

- Expected assumptions

Pessimistic

- Currency depreciation
- Drought
- Delayed machinery
- Lower sales



Response-Planning Exercise

Develop responses for:

- Exchange-rate risk
- Raw-material shortage
- Equipment failure
- Power interruption
- Skilled-labour shortage
- Market-demand risk
- Community opposition

Example Response — Currency Risk

Possible responses:

- Negotiate local-currency pricing
- Hedge foreign-currency exposure
- Purchase equipment early
- Hold foreign-currency reserves
- Increase contingency
- Escalate if exposure exceeds threshold

Example Response — Raw-Material Risk

Possible responses:

- Multiple suppliers
- Contract farming
- Buffer inventory
- Geographic diversification
- Alternative inputs
- Supplier-development programme



Example Response — Equipment Risk

Possible responses:

- Proven equipment
- Performance guarantee
- Preventive maintenance
- Initial spare-parts stock
- Local technical training
- Service contract



Risk-Register Exercise

Each group should prepare a register containing:

- Risk ID
- Cause
- Event
- Effect
- Category
- Probability
- Impact
- Score
- Response
- Owner
- Trigger
- Residual risk



Group Assignment

Each group should prepare:

- | | |
|--|-------------------------|
| 1. Risk-management plan | 1. Sensitivity analysis |
| 2. Risk Breakdown Structure | 2. Scenario analysis |
| 3. Risk-identification workshop output | 3. Risk-response plan |
| 4. Risk statements | 4. Contingency estimate |
| 5. Qualitative assessment | 5. Risk register |
| 6. Probability–impact matrix | 6. Monitoring dashboard |
| 7. EMV analysis | 7. Escalation framework |
| 8. Decision tree | |

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Chapter 10 · Review

Consolidating the Key Lessons



Common Risk-Identification Mistakes

- Listing vague topics instead of risks
- Ignoring opportunities
- Focusing only on technical risk
- Failing to identify causes
- Ignoring stakeholder risks
- Depending entirely on checklists
- Conducting identification only once



Common Risk-Analysis Mistakes

- Using inconsistent scales
- Assigning scores without evidence
- Treating risk scores as precise numbers
- Ignoring multiple impact dimensions
- Ignoring correlations
- Using unsupported probabilities
- Failing to assess residual risk



Common Response-Planning Mistakes

- No risk owner
- Vague response actions
- No deadline
- No contingency
- Transfer without checking counterparty capacity
- Acceptance without approval
- Failure to assess secondary risks
- Response cost exceeds expected benefit



Common Monitoring Mistakes

- Risk register not updated
- Overdue actions ignored
- Trigger conditions undefined
- Risks confused with issues
- No escalation thresholds
- No contingency review
- New risks not captured
- Closed risks not documented



Risk-Management Checklist

Confirm that:

- Risks are written clearly
- Threats and opportunities are included
- Causes and consequences are identified
- Categories are comprehensive
- Probability and impact scales are defined
- High risks have owners
- Responses are specific and funded
- Residual risks are assessed
- Triggers are documented
- Risk register is current
- Reviews are scheduled
- Escalation thresholds are clear



Knowledge Check

1. What is project risk?
2. How does a risk differ from an issue?
3. What is a risk appetite?
4. What are the main steps in project risk management?
5. What is a Risk Breakdown Structure?
6. What is qualitative risk assessment?
7. How is a probability–impact score calculated?
8. What is inherent risk?

1. What is residual risk?
2. What is Expected Monetary Value?
3. How does sensitivity analysis differ from scenario analysis?
4. What are the main threat-response strategies?
5. What is a contingency reserve?
6. What is a risk register?
7. When should a risk be escalated?



Knowledge Check Answers

1. An uncertain event or condition that may affect project objectives
 2. A risk is uncertain and future; an issue has already occurred
 3. The amount and type of risk an organization is willing to pursue or retain
 4. Plan, identify, analyze, respond, implement and monitor
 5. Hierarchical classification of project risks
 6. Relative prioritization using descriptive or ordinal measures
 7. Probability rating multiplied by impact rating
 8. Risk level before controls or responses
1. Risk remaining after responses
 2. Probability multiplied by monetary consequence
 3. Sensitivity changes one variable; scenario changes several related assumptions
 4. Avoid, mitigate, transfer, accept and escalate
 5. Time or money allocated for identified risks
 6. Living record of identified risks and their management
 7. When exposure exceeds project authority, tolerance or strategic limits



Individual Assignment

Select one proposed project and prepare:

- Project risk-management plan
- Risk Breakdown Structure
- At least 20 risk statements
- Threat and opportunity classification
- Qualitative risk assessment
- Probability–impact matrix
- Top-ten risk list
- Inherent and residual risk assessment
- Expected Monetary Value analysis
- Decision-tree analysis
- Sensitivity analysis
- Scenario analysis
- Response strategies
- Contingency calculation
- Risk register
- Key Risk Indicators
- Monitoring schedule
- Escalation framework
- Final risk-feasibility recommendation



Chapter Summary

- Project risk is uncertainty that may affect project objectives
- Risks may be threats or opportunities
- Distinguish risks from issues, assumptions and constraints
- Risk management is a continuous process
- Identification uses multiple methods and stakeholder perspectives
- Risk categories improve completeness and accountability
- Qualitative assessment prioritizes by probability and impact
- Probability–impact matrices support risk classification
- Quantitative analysis estimates the numerical effect of uncertainty
- Expected Monetary Value combines probability and financial consequence
- Decision trees compare alternatives under uncertainty
- Sensitivity analysis identifies critical variables
- Scenario analysis evaluates combinations of assumptions
- Threat responses: avoid, mitigate, transfer, accept, escalate
- Opportunities may be exploited, enhanced, shared or accepted
- Contingency reserves address identified risks
- The risk register documents exposure, ownership and response
- Monitoring tracks changes, effectiveness and emerging risks
- Escalation manages risks at the appropriate authority level



KEY MESSAGE

Risk management does not eliminate uncertainty. It improves the quality of project decisions by making uncertainty visible, assigning ownership and preparing proportionate responses before problems occur.

Identify → Categorize → Assess → Quantify → Respond → Register → Monitor →
Escalate → Learn

Project Implementation Planning and Control

The next chapter will cover:

- Project scope planning
- Work Breakdown Structure
- Activity definition
- Activity sequencing
- Duration estimation
- Network analysis
- Critical Path Method
- Gantt charts
- Resource planning
- Cost baselines
- Earned Value Management
- Change control
- Progress reporting
- Corrective action

THANK YOU

Questions and Discussion

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Projects rarely fail because uncertainty exists. They fail when important risks remain unidentified, unowned, poorly analyzed or unmanaged. Effective risk management turns uncertainty into informed action, realistic contingency and stronger project decisions.